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Case Report

Smartphone use undermines enjoyment of face-to-face social interactions☆

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ABSTRACT

Using a field experiment and experience sampling, we found the first evidence that phone use may undermine the enjoyment people derive from real world social interactions. In Study 1, we recruited over 300 community members and students to share a meal at a restaurant with friends or family. Participants were randomly assigned to keep their phones on the table or to put their phones away during the meal. When phones were present (vs. absent), participants felt more distracted, which reduced how much they enjoyed spending time with their friends/family. We found consistent results using experience sampling in Study 2; during in-person interactions, participants felt more distracted and reported lower enjoyment if they used their phones than if they did not. This research suggests that despite their ability to connect us to others across the globe, phones may undermine the benefits we derive from interacting with those across the table.

Decades of research on human happiness points to one central conclusion: Engaging in positive social interactions is critical for well-being (Baumeister & Leary, 1995; Epley & Schroeder, 2014; Kahneman, Krueger, Schkade, Schwarz, & Stone, 2004; Sandstrom & Dunn, 2014). But the current technological revolution may be altering how and when we derive these benefits. Smartphones enable us to connect with friends and family throughout the day, potentially allowing us to reap the benefits of social interactions even when we are alone. Could these devices—with their ability to connect us with anyone, anywhere—distract us from enjoying interactions with the people sitting right next to us?

In a recent Pew study, almost 90% of cell phone owners reported using their phones during their most recent social activity (*Pew Research Center*, 2015). Multi-tasking by using phones may be a major source of distraction in daily life, leaving people unable to concentrate fully on their primary activity. For example, using phones while driving is comparable to driving drunk (Strayer, Drews, & Crouch, 2006), using phones in the classroom has been shown to impede learning (Wood et al., 2012), and frequent notifications via phones can increase symptoms of inattention associated with ADHD (Kushlev, Proulx, & Dunn, 2016). Theoretically, distraction should also reduce the ability to derive pleasure from positive experiences (Brown & Ryan, 2003; Quoidbach, Berry, Hansenne, & Mikolajczak, 2010). Several studies lend support to this contention (e.g., Csikszentmihalyi, 1990; LeBel & Dubé, 2001), although this idea has not been tested directly. In addition to increasing distraction, phones may compromise the benefits of social interactions by increasing perceived opportunity costs; texting a romantic partner during lunch with friends or peeking at a work email during a family dinner may remind people of the other things they want or need to be doing. Thus, researchers have theorized that the mere presence of phones may orient people away from their immediate social environment, potentially decreasing enjoyment of social interactions (Przybylski & Weinstein, 2012; Srivastava, 2005). In sum, by increasing feelings of distraction or perceived opportunity costs, smartphone use may undermine the emotional benefits people derive from social interactions.

It is also possible, however, that phone use could play a positive role in social interactions. When a conversation lags or turns to dull topics, smartphones could provide reliable access to an array of brief engaging activities. Researchers have theorized that engaging one's attention with desired stimuli should decrease boredom, speed the passage of time, and promote a sense of agency (for a review, see Eastwood, Frischen, Fenske, & Smilek, 2012). By allowing us to engage our attention with an array of stimuli on demand, therefore, phones may decrease boredom, make time pass more quickly, and give us a greater sense of control.

There is abundant speculation about the possible effects of phones on social interactions (Turkle, 2012, 2015), but research examining how phone use shapes the benefits people derive from social interactions is in its infancy. Using correlational analyses, recent studies have documented a negative relationship between the presence of phones

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Table 1
Sample questionnaire items from Study 1.

Measure	α	Sample items	Source
Dependent variables			
Social connectedness	.77	I felt close to people.	Lee, Draper, & Lee, 2001
Affect: valence (mood)	.87	Pleasant.	Schimmack & Grob, 2000
Affect: tense arousal	.72	Jittery.	Schimmack & Grob, 2000
Affect: energetic	.90	Awake.	Schimmack & Grob, 2000
Interest and enjoyment	.69	I enjoyed this experience very much.	Ryan, 1982
Perceived control	.61	I felt I had control.	Bernstein & Claypool, 2012
Boredom	.83	I felt bored.	Fahlman et al., 2013
Time perception	.88	Time was dragging on.	Fahlman et al., 2013
Mediators			
Opportunity cost	–	Did you feel there were other things you wanted or needed to be doing?	Kushlev, 2011
Distraction	.54	I was easily distracted.	Feldman, Hayes, Kumar, Greeson, & Laurenceau, 2007

All items were measured on a scale from 1 (not at all) to 7 (very much), except social connectedness, perceived control, boredom, and time perception, which were measured on a scale from 1 (Strongly disagree) to 7 (Strongly agree).

and the quality of social interactions (Brown, Manago, & Trimble, 2016; Misra, Cheng, Genevie, & Yuan, 2014; Rotondi, Stanca, & Tomasuolo, 2017), and these studies are supported by similar findings in the lab (Przybylski & Weinstein, 2012; Vanden Abeele, Antheunis, & Schouten, 2016). However, no research has experimentally manipulated phone use in the real world, and research has yet to document the psychological mechanisms underlying the effects of phone use on the rewards derived from social interactions.

Thus, in Study 1, we conducted a field experiment in which we manipulated phone use during a central social activity—sharing a meal out with friends and family. In Study 2, we used experience sampling to capture the relationship between phone use and well-being across a wider range of social contexts over the course of a week. In both studies, we examined whether and how phone use affects the social and emotional benefits people reap during in-person social interactions. In line with current best practices, we pre-registered both studies, and we report all measures, conditions, and exclusions, as well as how sample sizes were determined.

1. Study 1

1.1. Method

1.1.1. Pre-registered power analysis

Based on a pilot study, we estimated an effect size of d = 0.4; using G*Power3, we calculated that we would need a sample size of N = 200 for 80% power, which we pre-registered on the Open Science Framework (OSF) at http://tinyurl.com/hwmo9t6. Given the high costs of this study, we planned and pre-registered three sequential analyses (at N = 100, 200, and 300); this technique allows for interim analyses by adjusting the critical alpha to control overall Type 1 error (see Lakens, 2014 for a primer on sequential analysis). At each analysis point, data collection can be stopped if results are significant at the adjusted alpha level. The results of our interim analyses led us to continue collecting data until we reached N = 300, with a pre-specified, adjusted alpha-level of 0.0278.

1.1.2. Participants

Because sessions were scheduled ahead of time, we slightly surpassed our target sample size, with 304 participants (64% females, ages = 19–69, M = 29.9 years, SD = 10.6). The sample included both university students (34%) and adults from the Vancouver, BC community (66%). An additional 2 participants did not have usable data due to a technical error that occurred while completing the survey. We required that all participants own a smartphone, ostensibly so that they could receive study-related reminders and survey questions.

1.1.3. Procedure and measures

Participants were invited to complete a “study investigating people's experience dining out with friends.” Groups of 3–5 friends or family members participated in the study at a local café. After providing consent, each group was randomly assigned to the *phone* or *phoneless* condition. Specifically, to manipulate phone use without revealing the purpose of the study, we told participants in the *phone* condition that they would be asked to answer a survey question after ordering their food, and that the RA would text them this question; to ensure that they received the survey, they were told to set their phone on the table with the ringer or vibration on. In the *phoneless* condition, participants were also told that they would answer a survey question, which would be handed to them on paper; these participants were then instructed to turn their phones on silent and place them in a container on the table. To support our cover story, we asked participants to rate how they were feeling that day on a scale from 0 to 100 via text (phone condition) or paper (phoneless condition). Participants then ate their meal together without further interruption by the experimenter.

After their meal, all participants were given iPads to complete a questionnaire (thereby maximizing the privacy of their responses; for complete survey see http://tinyurl.com/hwmo9t6). This questionnaire included our key measures of social connectedness, affect, opportunity costs, interest/enjoyment, distraction, perceived control, time perception, and boredom, in that order (see Table 1 for details on all measures). Next, participants were asked to answer questions about their overall amount of phone use during the session (providing a manipulation check); we also included exploratory questions about the nature of their phone use (e.g., text messaging, social media, photos). Finally, participants were asked to indicate the nature of their relationship to each other person in the group (e.g., spouse, sibling, friend), and to provide demographics. After completing this survey, participants were asked to provide feedback about the study and to report how many notifications they received on their phones. In exchange for participating, each participant received up to $20 to spend toward their group's total bill. All sessions were videotaped using a small camera (GoPro Hero 4) positioned so that it was visible but unobtrusive. To minimize any potential for experimenter bias, research assistants were kept blind to our hypotheses. During the meal, research assistants sat at a separate table without observing participants.

1.1.4. Manipulation checks

We asked participants to report “During the dining experience today, how often did you use your mobile phone?” from *Not at all* (1) to *Constantly* (7). To capture phone use compared to participants' normal behavior, we asked “How frequently did you use your phone as compared to how you would have normally used your phone in a restaurant with your friends/family?” from *Much less* (−3) to *Much more* (3). To provide an objective behavioral measure, the amount of time participants spent interacting with their phones was assessed by two coders, and then divided by the total duration of the video. Coders showed high agreement (α = .95) and thus we averaged their ratings.

1.1.5. Pre-registered hypotheses

We pre-registered our main hypotheses at the Open Science Framework (http://tinyurl.com/hwmo9t6). Specifically, we predicted that phone use would undermine the benefits people derived from sharing a meal with others, such that participants in the phone (vs. phoneless) condition would experience less social connectedness, more tense arousal, less pleasant affect, and less interest/enjoyment (see Table 1). We expected that these negative effects would be mediated by distraction or by perceived opportunity costs. We also anticipated that phone use would provide benefits by giving people a greater sense of perceived control, reducing boredom, and making time seem to move faster. We expected that the positive and negative effects of being assigned to the phone condition would be amplified for individuals who used their phones heavily during the meal.

1.2. Results

1.2.1. Analytic strategy

Because all participants within a group were assigned to the same condition, we employed multilevel modeling (MLM), which accounts for non-independence. In these data, participants (level 1) are nested within groups (level 2). We used SPSS 24 to run all reported mixed models. For all of the models, we used maximum likelihood estimation and treated predictors as fixed effects, allowing only the intercept to vary as a random effect at the person level. The reported fixed effects below represent the effect of Condition (level-2 variable) on participants' feelings and behavior (level-1 variables).

1.2.2. Manipulation checks

Confirming the success of our manipulations, participants in the phone condition reported using their phones more during the study (M = 2.21, SD = 1.31) than those in the phoneless condition (M = 1.07, SD = 0.31), $b = 1.16$, $t(73.45) = 8.79$, $p < .001$. Participants in the phone condition reported using their phones slightly less than normal (M = − 0.63, SD = 1.24), while participants in the phoneless condition reported using their phones much less than normal (M = − 1.79, SD = 1.44), creating a significant difference between conditions, $b = 1.16$, $t(72.02) = 7.31$, $p < .001$. Additionally, coders' objective ratings confirmed that participants in the phone condition used their phones for a greater percentage of time during the sessions (M = 11%, SD = 8%) compared to those in the phoneless condition (M = 1%, SD = 2%), $b = 0.11$, $t(79.31) = 10.02$, $p < .001$.

1.2.3. Pre-registered hypotheses

Consistent with our pre-registered hypothesis, participants in the phone condition reported significantly lower interest and enjoyment than those in the phoneless condition, $b = -0.37$, $t(82.75) = -2.55$, $p = .013$ (see Tables 2 and 3). Participants in the phone (vs. phoneless) condition also reported feeling more distracted, $b = 0.46$, $t(79.08) = 3.14$, $p = .002$. In contrast to our original prediction—but consistent with the other negative effects of phone use—participants reported marginally higher boredom, $b = 0.28$, $t(77.06) = 2.15$, $p = .035$. Similarly, participants in the phone (vs. phoneless) condition reported worse subjective experience on all of our other dependent variables, although these effects were not significant.[1] Our dependent variables were significantly correlated, $\bar{r} = .38$, which inflates the family-wise Type I error. We accounted for this by calculating the average effect across all our outcome variables. We found that phone use had a small negative effect on well-being, $d = -0.31$, bootstrapped 95% CI $[-0.43, -0.12]$.

Table 2
Means and standard deviations for measures in Study 1.

	Phone ($n = 152$)	Phoneless ($n = 152$)
Dependent variables	M (SD)	M (SD)
Social connectedness	5.78 (0.82)	5.82 (0.79)
Valence	5.99 (0.89)	6.12 (0.82)
Tense arousal	2.65 (0.97)	2.55 (0.88)
Energetic arousal	4.8 (1.23)	5.05 (1.2)
Interest/enjoyment	4.98 (1.17)	5.36 (1.02)
Control	4.85 (0.84)	4.97 (0.94)
Boredom	2.21 (1.19)	1.93 (1.02)
Time perception	2.04 (1.17)	1.85 (1.1)
Mediator variables	M (SD)	M (SD)
Opportunity cost	2.84 (1.66)	2.92 (1.63)
Distraction	2.84 (1.2)	2.38 (1.03)

Table 3
Summary of fixed effects for MLM analyses in Study 1.

DV	b	df	t	p
Social connectedness	− 0.03	80.52	− 0.31	.758
Valence	− 0.12	79.72	− 1.14	.257
Tense arousal	0.1	83.01	0.9	.369
Energetic arousal	− 0.25	79.96	− 1.64	.106
Interest/enjoyment	− 0.37	82.75	− 2.55	.013
Control	− 0.11	81.66	− 1	.323
Boredom	0.28	77.06	2.15	.035
Time perception	0.18	75.17	1.31	.194

Note. See Table S-1 in SOM for full model statistics.

1.2.4. Mediation

We conducted all mediation analyses using Rockwood and Hayes' (2017) MLmed macro for SPSS with robust standard errors (REML estimation). We estimated all nonredundant parameters for a 2-1-1 mediational model, including fixed and random intercepts, fixed effects, and the random effect between mediator and outcome (the random effects for condition were redundant). Only between-group effects were estimated—there is no within-group effect for condition, which is a Level 2 (group-level) variable. Covariances between random intercepts and effects are also not modelled in 2-1-1 mediational models. Although we originally predicted that distraction and opportunity costs might mediate the effects, condition only affected distraction, $b = 0.46$, $p = .003$. In turn, distraction significantly predicted interest/enjoyment, $b = -0.29$, $p = .008$. Thus, we examined whether distraction mediated the effect of condition on interest and enjoyment. Indeed, we found an indirect effect of condition on interest/enjoyment through distraction, $b = -0.13$, $Z = -1.99$, $p = .046$, which was marginal by our more stringent alpha level. Condition was no longer a significant predictor of interest and enjoyment after controlling for distraction, $b = -0.23$, $p = .121$, suggesting that the negative effect of phone use on interest/enjoyment was due in part to people being distracted by their phones.

Our manipulation also had significant indirect effects, via distraction, on nearly all of our dependent measures; that is, the presence of phones led people to feel more distracted, which in turn was associated with less positive affect valence, more tense arousal, less energetic arousal, less control, and more boredom (see Table 4).

1.3. Discussion

In the real-world setting of a café, we found that people enjoyed a

[1] We also predicted that the negative effects of phone use would be amplified for participants who exhibited the highest levels of phone use. We did not find consistent support for this hypothesis (see SOM).

Table 4
Mediational and indirect effects of phone use through distraction in Study 1.

				Indirect effect		
Outcome variable	Path b	Path c	Path c'	$a * b$	95% CI	Sobel Z
Social connectedness	− 0.22**	− 0.03	0.07	− 0.10†	[− 0.21, − 0.02]	− 2.13
Valence	− 0.39***	− 0.12	0.06	− 0.18**	[− 0.32, − 0.06]	− 2.67
Tense arousal	0.44***	0.10	− 0.10	0.21**	[0.07, 0.36]	2.73
Energetic arousal	− 0.38***	− 0.25	− 0.08	− 0.17**	[− 0.34, − 0.05]	− 2.24
Interest/enjoyment	− 0.29**	− 0.37*	− 0.23	− 0.13†	[− 0.29, − 0.03]	− 1.99
Control[a]	− 0.31***	− 0.11	0.03	− 0.14*	[− 0.28, − 0.04]	− 2.35
Boredom[b]	0.46***	0.28†	0.06	0.21**	[0.07, 0.38]	2.65
Time perception	0.23†	0.18	0.07	0.11	[0.01, 0.24]	1.75

Note. The effect of condition on distraction (path a) is significant for all DV's, $b = 0.46$, $p = .003$. Path b represents the effect of distraction on each outcome variable. Path c represents the total effect of phone use on each outcome variable. Path c' represents the direct effect of phone use on each outcome variable after accounting for the indirect effect through distraction. Confidence intervals were estimated using 10,000 Monte Carlo stimulations.

†$p < .05$. *$p < .027$. **$p < .01$. ***$p < .001$.

[a] There was little variability in the slope from the mediator to outcome variable, so the model did not converge. Thus, we did not estimate the random M to Y slope for the Control variable.

[b] There was little variability in the Y intercept, so the model did not converge when it the random Y intercept was included in the model. Thus, the model used for the Boredom variable included a fixed Y intercept only.

meal with their friends less when phones were present than when phones were put away. They also felt more distracted when phones were present (vs. absent), which had negative downstream consequences for their broader subjective experience (e.g., more tense arousal and boredom). Taken together, these results provide initial evidence that phone use may undermine some of the benefits people derive from the central social experience of sharing a meal. However, given that the effects were somewhat weak statistically and that we examined only one social setting, we conducted a second study examining phone use, distraction, and well-being across diverse social interactions. By using a within-subjects design and collecting data across numerous time points, we sought to enhance power to detect the effects initially observed in our between-subjects experiment.

2. Study 2: experience sampling

In Study 2, we surveyed people 5 times a day for one week, asking them to report how they had been feeling and what they had been doing over the past 15 min.

2.1. Method

2.1.1. Preregistration

We preregistered our hypotheses and analysis plan on the Open Science Framework (http://tinyurl.com/z7xe43d). Based on Study 1, we predicted that during social interactions, people would feel more distracted and would experience less enjoyment when they were using smartphones compared to when they were not using smartphones. In addition, consistent with Study 1, we expected that phone use would have detrimental indirect effects (via distraction) on social connectedness, affect valence, boredom, and time perception. We preregistered to collect at least 100 usable participants with replacement. Participants were considered unusable for the analyses if they had no episodes when they interacted with others in person.

2.1.2. Participants

Students at a large public university in the U.S. who owned smartphones participated for course credit. In total, we obtained usable data from 123 participants ($M_{age} = 18.6$, 69% women; see SOM for further details). The participants responded to a total of 3008 ESM surveys (68.6% of surveys sent), of which 1244 were episodes when they were interacting with others face-to-face.

2.1.3. Procedure and measures

Participants completed a demographic survey, and on the following day, they began to receive links to brief ESM surveys sent via text message using the service surveysignal.com. For seven days, participants received five prompts per day between 9 am and 9 pm. Within this 12-hour period, the prompts were sent randomly within five equally divided intervals. Each message instructed participants to respond as quickly as they safely could. The links expired after 1 h, and each survey was administered at least 2 h after the previous prompt.

At the top of each survey, participants were instructed that all the questions pertained to their experience "over the last 15 min before completing the survey." Participants then completed brief versions (adapted for ESM) of selected measures from Study 1. Specifically, participants reported whether they had enjoyed their experience in the last 15 min and whether they would describe their experience as very interesting (1 – *Not true*; 7 – *Very true*). We averaged these two responses to form our composite measure of interest/enjoyment ($\alpha = .80$). Affect valence, social connectedness, distraction, boredom, and time perception were each measured on 7-point scales using single items adapted from Study 1; for the full survey, see http://tinyurl.com/hau2wck.

At the end of the survey, participants were asked what they had been doing in the past 15 min, including how much they had used their smartphones (1 – *Not at all*; 7 – *Constantly*). As preregistered based on the findings in Study 1, this measure was transformed into a dichotomous measure of whether or not people used their phones during the episode. To dichotomize phone use, we coded as 0 episodes when participants reported using their phones 'not at all', and coded any use as 1 (i.e., 2–7 were coded as 1). Participants also indicated whether or not they had "socialized in person/face-to-face," among a number of other common daily activities (e.g., eating/drinking, working/studying).

2.2. Results

2.2.1. Analytic strategy

We pre-registered our analysis plan on OSF; see http://tinyurl.com/z7xe43d. Because each person had multiple episodes, we used multilevel modeling (MLM) to estimate the effects. For all of the models, we used SPSS 24, specifying restricted maximum likelihood estimation and treating predictors as fixed effects, allowing only the intercept to vary as a random effect at the person level.[2]

[2] Estimating the random component of each effect did not substantively change the size of the fixed component or the significance level.

2.2.2. Effects of phone use

As predicted, during episodes that included face-to-face social interactions (N = 1244), people reported feeling more distracted when they used their smartphones than when they did not, $b = 0.95$, $SE = 0.11$, $t(91.98) = 8.23$ $p < .001$ (see Table 5 for means). In addition, during these episodes, participants experienced less interest and enjoyment when they used smartphones than when they did not, $b = -0.41$, $SE = 0.09$, $t(1239.60) = -4.44$, $p < .001$. Although we did not predict direct effects of phone use on the other outcomes, we found that people also reported worse affect, $b = -0.31$, $SE = 0.09$, $t(1237.09) = -3.46$, $p = .001$, felt less socially connected, $b = -0.33$, $SE = 0.09$, $t(1234.80) = -3.87$, $p < .001$, more bored, $b = 0.53$, $SE = 0.10$, $t(1240.14) = 5.25$, $p < .001$, and perceived time to be moving slower, $b = 0.34$, $SE = 0.11$, $t(1239.77) = 3.20$, $p = .001$ (see Table S-3 for exhaustive list of model parameters for all reported models). In additional exploratory analyses, we used the continuous phone use variable as the predictor (1 – *Not at all*; 7 – *Constantly*) and found the same effects across all outcomes (all p's $< .001$). As in Study 1, our dependent variables were significantly correlated, $\bar{r} = .50$, which inflates family-wise Type 1 error. Calculating the average effect across our variables, we found that social interactions with phone use were associated with a small decrease in well-being compared to social interactions without phone use, $d = -0.23$, bootstrapped 95% CI $[-0.034, -0.14]$.

2.2.3. Mediation analyses

As preregistered, we used person-level means for the mediation analyses. For distraction and all outcome variables, we first aggregated each participant's scores separately for episodes with versus without smartphones. We then predicted the difference scores between the means of the outcome variables (e.g. interest/enjoyment) when people were using versus not using their phones from the difference and sum scores of distraction (i.e., the mediator). As in Study 1, we conducted all mediation analyses using Rockwood and Hayes' (2017) MLmed macro for SPSS. All random effects were estimated, within- and between-persons effects were deconflated, and covariances were estimated except for the covariance between the intercepts of the mediator and outcome variables. Because we were interested how the same people felt when using their phones or not, we focus on the within-subjects effects below (see Table S-4 for between-subject effects). We examined whether distraction could explain the effect of phone use on our outcome variables.[3] We found support for the mediating role of distraction across all outcomes (see Table 6). To the extent people felt more distracted when they used their phones, they reported feeling less enjoyment, worse affect, less socially connected, more bored, and slower time perception.

Table 5
Means for episodes with face to face interactions with phone use versus no phone use in Study 2 (N = 1244).

	With phone use *M* (*SD*)	No phone use *M* (*SD*)
Distraction	3.45 (0.91)	2.42 (1.26)
Interest/enjoyment	4.78 (1.01)	5.33 (1.25)
Affect valence	5.28 (0.98)	5.77 (1.11)
Connectedness	5.39 (0.97)	5.92 (1.03)
Boredom	2.97 (0.97)	2.28 (1.13)
Time perception	3.11 (1.11)	2.70 (1.53)

Note. In total, 120 people had episodes with phone use, whereas 96 people had episodes without phone use. This could explain why the standard deviations for episodes with phone use are smaller than those for episodes with no phone use.

Table 6
Within-subjects indirect effects of phone use through distraction in Study 2.

			Indirect effect		
	Path c	Path c'	$a*b$	95% CI	Sobel Z
Interest/enjoyment	-0.45^{***}	$-0.21^{\dagger}$	-0.22^{***}	[−0.33, −0.11]	−3.85
Affect valence	-0.34^{**}	−0.16	-0.18^{***}	[−0.29, −0.08]	−3.35
Connectedness	-0.35^{***}	−0.13	-0.22^{***}	[−0.33, −0.11]	−3.97
Boredom	0.56^{***}	$0.21^{\dagger}$	0.36^{***}	[0.21, 0.51]	4.79
Time perception	0.33^{*}	0.04	0.29^{***}	[0.11, 0.47]	3.24

Note. Path c represents the total effect of phone use on each outcome variable. Path c' represents the direct effect of phone use on each outcome variable; that is, the remaining effect of phone use after accounting for the indirect effect through distraction. Confidence intervals were estimated using 10,000 Monte Carlo stimulations.
$^{\dagger}p < .10$. $^{*}p < .05$. $^{**}p < .01$. $^{***}p < .001$ (significance based on Sobel's Z test of mediation).

3. General discussion

Using a field experiment and intensive experience sampling, we found the first evidence that phone use undermines the enjoyment people derive from real world social interactions. In Study 1, phone use caused individuals to feel distracted, which reduced how much they enjoyed sharing a meal with friends at a local café. In Study 2, we obtained similar results by asking people to report what they had been doing and feeling during the past 15 min. When they had been engaging in face-to-face interactions, they felt more distracted and reported lower enjoyment if they had been using their smartphones than if they had not. Phone use also had indirect negative effects, via distraction, on other well-being outcomes; in both studies, phone use predicted distraction, which in turn predicted greater boredom and worse overall mood.

Going beyond previous research, we found these effects in naturalistic contexts by conducting a field experiment in a café and by using experience sampling to capture a variety of real-world social situations. These results held across two distinct samples, including both students and community members in Western Canada (Study 1), and students in the Southern United States (Study 2). It is especially notable that we observed negative effects of phone use among university students. This generation has grown up with mobile technology, and some have raised the possibility that young people might therefore be relatively adept at multi-tasking in real world contexts (Foehr, 2006). This idea is particularly compelling in the context of extended social interactions, such as sharing a meal with friends, given that natural lulls in conversation might afford the ability to attend to one's phone without any detectable cost. Yet, our findings suggest that even the moderate levels of phone use we observed are sufficient to create feelings of distraction that undermine the emotional rewards of social interaction.

These results build on other recent work showing that phone use is associated with less positive social impressions (Vanden Abeele et al., 2016), lower interaction quality with friends (Brown et al., 2016; Misra et al., 2014), and lower relationship satisfaction with a romantic partner (Roberts & David, 2016). We found that the negative effects of phone use were mediated by distraction, but not opportunity costs, suggesting that phone use prevents individuals from fully engaging in the present moment. Contrary to our original prediction, phones slightly increased boredom. While Eastwood et al. (2012) argue that interesting stimuli can decrease boredom, they also theorize that relatively subtle sources of distraction may lead people to misattribute their feelings of inattention to being bored with the situation. For example, people report greater boredom when a TV plays quietly in another room than when it is blaring (Damrad-Frye & Laird, 1989). Thus, people may

[3] The sample used for the mediation analyses was smaller than the total sample because these analyses require people to have episodes both with and without reported phone use. The number of participants who had both episodes with reported distraction was N = 93. As indicated by the total effects in Table 6, the effects of phone use on the outcome variables mirrored those from the MLM analyses reported above.

anticipate that phones will reduce boredom (as we did), but by providing a subtle source of distraction, phones may ironically increase boredom.

Still, it is important to note that the observed effects in both studies, as shown by the meta-analyses, were relatively small. Based on the effect size ($d = -0.31$) observed across variables in Study 1, future experiments should include at least 165 participants per condition to detect reliable effects. As this high required sample size illustrates, phones may have minimal negative effects on individual social interactions; however, these small effects are likely consequential over time. McDaniel and Coyne (2014) argue that small, frequent interruptions from phones can compound into relationship conflict and lower life satisfaction. Our study provides a window into one underlying process through which phone use may chip away at life satisfaction: phones may undermine the enjoyment derived from face-to-face social interactions.

Of course, everyday life is riddled with other sources of distraction, such as newspapers and television, but phones differ from these earlier forms of information technology in two critical ways: Phones provide access to a virtually infinite array of potential diversions, while being so portable that they are almost always with us, enabling them to easily pervade our social interactions. For example, a recent observational study found that caregivers exhibited a high degree of absorption in their phones while sharing a meal with children at fast food restaurants (Radesky, Kistin, Augustyn, & Silverstein, 2014). Theoretically, then, smartphones provide an ideal proxy for studying how the increasing pervasiveness of our digital activities is interacting with fundamental human activities (e.g., sharing a meal).

Our studies have several limitations. Because participants in Study 1 were assigned to the phone or phoneless condition in groups, it is unclear whether the effects were caused by the individual's phone use, the phone use of others in the group, or an interaction between individual and group phone use. For example, Sally might experience reduced enjoyment if her dining companions were using their phones while she was not. Thus, an interesting open question is how individual and group phone use interact. It is also possible that some participants guessed the purpose of our studies, and thus responded according to their lay beliefs about phone use. In both studies, however, we ensured our interest in phone use was minimally salient by embedding any mention of phones within broader study instructions or questionnaire items.

Whereas Study 1 used an experimental design, Study 2 relied on a correlational design and thus may have captured bi-directional effects between phone use and participants' feelings; for example, phone use may have increased distraction, but feeling distracted could also have promoted phone use. Another limitation of Study 2 is that we may have inadvertently increased participants' typical phone use by about five instances per day by asking participants to use their phones to complete surveys about phone use. According to a Deloitte (2016) report, however, 18–24 year olds use their phones 82 times a day on average. Thus, the survey method likely only increased phone use by around 6%. Given the small magnitude of this increase, we think it is fairly unlikely to have fundamentally altered the relationship between phone use and our well-being measures. Finally, although we have framed these results as showing negative effects of phone use, it would be equally valid to describe these results as showing positive effects of putting phones away. That is, it is possible that putting phones away increases attention, which in turn increases well-being outcomes. Given the ubiquity of phones in everyday life, we think either causal pathway is important and the main principle is the same: enjoyment is higher during social interactions without phones.

Although we found that phone use negatively affected enjoyment of social interactions, phones should have positive effects in situations where distraction is desirable. Indeed, phone use has been found to reduce the need for anesthesia during minor surgery (Guillory, Hancock, & Woodruff, 2015). By affecting distraction, phones may also have a wide range of other psychological consequences. Distraction has been linked to reduced memory (Craik, Govoni, Naveh-Benjamin, & Anderson, 1996), increased stress (Mark, Gudith, & Klocke, 2008), and reduced self-control (Shiv & Fedorikhin, 1999), pointing to the value of testing the effects of phone use on these outcomes.

Our research may also serve as a model for future experimental studies, given that the literature on phones and well-being has disproportionately utilized correlational designs (Brown et al., 2016; Kushlev & Heintzelman, in press; Misra et al., 2014; Rotondi et al., 2017). Several other new studies have manipulated the presence of phones during social interactions and cognitive tasks (Allred & Crowley, 2017; Avelar, 2015; Lyngs, 2017), but these studies have relied on small samples (cell sizes ≤ 25) and have produced mixed results, highlighting the need for well-powered, confirmatory research in this area.

Research on the cognitive effects of distraction have led governments to enact policy changes restricting phone use while driving (World Health Organization, 2011), and many course instructors have implemented analogous policies in their classrooms (Hammer et al., 2010). In a similar vein, our research highlights the need for change in social norms surrounding phone use in social interactions. In particular, this work reveals how phones can distract us from engaging with people in our immediate environment. Despite their ability to connect us to others across the globe, phones may undermine the benefits we derive from interacting with those across the table.

Author contributions

All authors contributed to the study design. Data collection, analysis and interpretation for Study 1 was performed by R. J. Dwyer under the supervision of E. W. Dunn and K. Kushlev. Data collection, analysis and interpretation for Study 2 was performed by K. Kushlev. R. J. Dwyer drafted the manuscript, and E. W. Dunn and K. Kushlev provided critical revisions. All authors approved the final version of the manuscript for submission.

Open practices

All data have been made publicly available via the Open Science Framework. The data for Study 1 can be viewed at http://tinyurl.com/hwmo9t6, and the data for Study 2 can be viewed at http://tinyurl.com/zvgu6hh.

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Appendix A. Supplementary materials

Supplementary data to this article can be found online at https://doi.org/10.1016/j.jesp.2017.10.007.

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